CLAIMS

We claim:

1. A modular apparatus for detecting a target analyte, the apparatus comprising:

a reservoir module comprising:

a fluid manifold base; and

a plurality of reservoirs coupled to the fluid manifold base;

a microfluidic chip comprising:

a plurality of inlets;

a separation channel in fluid communication with at least one of said inlets;

a seal positioned between the fluid manifold base and the microfluidic chip, the seal defining at least one area of fluidic communication between one of said reservoirs and one of said inlets;

a detection module positioned to interrogate at least a portion of the separation channel; and

an output interface in communication with said detection module to indicate detection of the target analyte.

2. A modular apparatus according to claim 1, wherein the reservoirs are each coupled to the fluid manifold base with a fitting.

3. A modular apparatus according to claim 1, wherein at least one reservoir further comprises a reservoir seal, said fluid manifold base further comprising at least one needle penetrating said reservoir seal.

4. A modular apparatus according to claim 1, wherein the needle is in fluidic communication with at least one inlet.

5. A modular apparatus according to claim 1, wherein at least one reservoir comprises:

a plurality of chambers; and

a barrier between the chambers.

6. An apparatus according to claim 5, where in the barrier comprises Nafion or nanoporous glass.

7. An apparatus according to claim 5, wherein one of said plurality of chambers is in fluidic communication with at least one of said inlets, and a second of said plurality of chambers is in electrical communication with a power module.

8. An apparatus according to claim 1, wherein the microfluidic chip further comprises a plurality of inlets, the apparatus further comprising:

a sample introduction port connected to at least one of said plurality of inlets.

9. An apparatus according to claim 1, wherein each of said plurality of reservoirs further comprsises an electrode; the apparatus further comprising:

a power module in communication with each of said electrodes.

10. An apparatus according to claim 9, wherein said power module is further in communication with said detection module.

11. An apparatus according to claim 1 wherein said separation channel comprises a low-dispersion curve.

12. An apparatus according to claim 1, wherein said microfluidic chip comprises a plurality of separation channels.

13. An apparatus according to claim 1, wherein said modular apparatus is portable.

14. An apparatus according to claim 1, wherein said modular apparatus is hand-held.

15. An apparatus according to claim 1, wherein the microfluidic chip, the reservoir module, the fluid manifold base, and the detection module are contained in a single housing.

16. An apparatus according to claim 1, wherein the detection module comprises a laser.

17. An apparatus according to claim 11, wherein the laser comprises a violet laser diode or a red laser diode.

18. An apparatus according to claim 1, further comprising a plurality of microfluidic chips.

19. An apparatus according to claim 18, further comprising a plurality of fluid manifold bases.

20. An apparatus according to claim 18, wherein each of said microfluidic chips are configured to perform a different microfluidic separation.

21. An apparatus according to claim 18, further comprising a plurality of detection modules.

22. A method for reseting a reservoir in a portable device for target analyte detection, the method comprising:

placing a first reservoir in fluid communication with an inlet of a microfluidic chip;

removing said first reservoir from fluid communication with the microfluidic chip; and

placing a second reservoir in fluid communication with the inlet of the microfluidic chip, wherein the act of removing said first reservoir and placing said second reservoir maintains a contiguous fluid stream between an inlet of the microfluidic chip and a separation channel within the microfluidic chip.

23. A method according to claim 22, wherein the act of removing said first reservoir and placing said second reservoir prevents gas incursion into the microflduic chip.

24. A method according to claim 22 wherein the act of removing said first reservoir and placing said second reservoir does not generate a bubble within said microfluidic chip.

25. A method according to claim 22, wherein said first and second reservoirs each comprise a seal, the act of placing said first reservoir and the act of placing said second reservoir further comprising penetrating said seal.

26. A method for determining the presence of a target analyte in a sample using a portable device comprising a sample introduction port and an output interface, said method comprising;

coupling a plurality of reservoirs to a microfluidic chip within the portable device through a fluid manifold base;

contacting said input port with a sample;

performing a microfluidic separation according to a first separation characteristic within said portable device using at least a portion of said sample;

detecting at least a first separated component of said sample, based on said microfluidic separation;

identifying said target analyte in said sample, based on said component; and

indicating detection of said target analyte on said output interface.

27. A method according to claim 26, further comprising:

performing a plurality of microfluidic separations, each according to a different separation characteristic; and

identifying said target analyte based on said plurality of separation characteristics.

28. A method according to claim 26, wherein the target analyte is selected from a group of analytes consisting of viruses, bacteria, microorganisms, biotoxins, and chemical toxins.

29. A method according to claim 26, further comprising:

carrying said portable device to a site; and

collecting said sample.

30. A method according to claim 26, wherein the act of detecting comprises interrogating a detection area within the portable device with an optical device within the portable device.

31. A method according to claim 30, wherein said optical device comprises a violet laser.

32. A method according to claim 26, wherein said first separated component comprises a non-nucleic acid component.

33. A method according to claim 26, wherein the act of performing a first microfluidic separation comprises performing a separation chosen from the group of separations consisting of: capillary zone electrophoresis, liquid chromatography, capillary gel electrophoresis, isotachophoresis, capillary electrochromatography, micellar electrokinetic chromatography, and isoelectric focusing.

34. A method according to claim 26, wherein the act of detecting a first separated component comprises detecting fluorescence, and wherein said fluorescence detector is within the portable device.

35. A method according to claim 26, wherein the act of detecting a first separated component comprises electrochemically detecting said first separated component, and wherein the electrochemical detector is within the portable device.

36. A method according to claim 26, wherein the act of indicating the detection of the target analyte comprises generating a visual display.

37. A method according to claim 26, wherein said portable device further includes an optical detector for detecting said first separated component, the method further comprising:

removing said optical detector from the portable device;

placing a second optical detector into the portable device;

performing a second microfluidic separation; and

detecting a second separated component using said second optical detector.

38. A method according to claim 37, wherein said first optical detector comprises a first optical source and said second optical detector comprises a second optical source, said first and second optical sources emitting different wavelengths.

39. A method according to claim 26, wherein said performing a microfluidic separation comprises applying a voltage across at least a portion of said sample, said portable device further comprising a power module for generating said voltage; the method further comprising:

removing said power module from said portable device;

placing a second power module into said portable device; and

performing a second microfluidic separation using said second power module.

40. A method according to claim 39, wherein said first and second power modules are configured to generate different voltages.

41. A portable device for analyzing a liquid sample, said device, comprising:

a housing including a top plate, a bottom plate, and a back plate enclosing;

means for receiving the liquid sample,

an analysis module, wherein said analysis module comprises, in combination,

a module for separating the sample into its components, said module in fluid communication with said receiving means, and

a module for detecting the separated components by producing and acquiring a signal;

means for supplying high voltage to said analysis module;

means for converting the signal into an elution spectrum; and

means for the display of the elution spectrum.

42. The device of claim 41, wherein the signal is a fluorescence signal.

43. The device of claim 41, wherein the signal is an electrochemical signal.

44. The device of claim 41, wherein said modules are separable.

45. The device of claim 41, further including a dovetail rail assembly connecting said analytical module to the bottom plate of said housing thereby vibrationally isolating said analytical module and providing for its independent removal and replacement.

46. The device of claim 41, wherein said separation module, comprises:

housing means for containing at least one fluid reservoir;

means for connecting the fluid reservoir to the high voltage supply;

a microfluidic chip; and

means for transporting fluid from the fluid reservoir to said microfluidic chip, wherein said means for transporting maintains a contiguous fluid stream between the fluid reservoir and said microfluidic chip.

47. The device of claim 46, wherein said microfluidic chip comprises:

a microchannel structure comprising at least one sample channel and at least one separation channel in fluid communication, wherein said microchannel structure is disposed on a substrate; and

spaced electrodes in fluid communication with said microchannel structure.

48. The device of claim 47, wherein the substrate is silicon, quartz, glass, or a polymer material.

49. The device of claim 47 ,wherein at least a portion of the internal surface of the separation channel is coated with a coating.

50. The device of claim 47, wherein the separation channel is configured to provide multiple channel depths.

51. The device of claim 41, wherein said detector module comprises:

a light source;

means for focusing the light onto said separating module and collecting the emitted light;

means for directing light from said light source to said focusing means;

means for sensing the emitted light; and

means for analyzing the emitted light.

52. The device of claim 51, wherein said light source is a light-emitting diode, a laser, a laser diode, a vertical cavity surface emitting laser, a vertical external cavity surface emitting laser, or a dipole pumped solid state laser.

53. The device of claim 51, wherein said means for focusing and collecting is a high numeric aperture, aspheric or ball-type lens.

54. The device of claim 51, wherein said means for directing is a four mirror configuration.

55. The device of claim 51, wherein said means for sensing includes photomultiplier tubes, photodiodes, avalanche photodiodes, photodiode arrays, charge-coupled devices, or photosensitive detectors.

56. The device of claim 41, wherein the liquid sample includes a gas or an aerosol, and wherein the gas or aerosol is processed to produce the liquid sample